

WHAT IS CLAIMED IS:

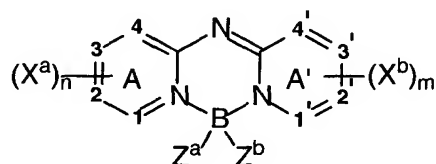
1. An organic light-emitting diode (OLED) device that produces white light, including:
 - a) an anode;
 - b) a hole-transporting layer disposed over the anode;
 - c) a blue light-emitting layer disposed over the hole-transporting layer;
 - d) an electron-transporting layer disposed over the blue light-emitting layer;
 - e) a cathode disposed over the electron-transporting layer; and
 - f) the hole-transporting layer including a host material, a yellow dopant, and a red dopant.
2. The OLED of claim 1 wherein the blue light-emitting layer includes a host material and a blue dopant.
3. The OLED of claim 2 wherein the host material in the blue light-emitting layer includes an anthracene derivative having hydrocarbon or substituted-hydrocarbon substituents at the 9 and 10 positions.
4. The OLED of claim 2 wherein the host material includes 9,10-di-(2-naphthyl)anthracene (ADN) or 2-*t*-butyl-9,10-di-(2-naphthyl)anthracene (TBADN).
5. The OLED of claim 2 wherein the blue dopant includes perylene or a derivative of perylene.
6. The OLED of claim 2 wherein the blue dopant includes 2,5,8,11-tetra-*t*-butyl perylene (TBP).

7. The OLED of claim 2 wherein the blue dopant includes a blue-emitting derivative of a distyrylbenzene or a distyrylbiphenyl.

8. The OLED of claim 2 wherein the blue dopant includes a bis[2-[4-[N,N-diaryl]amino]phenyl]vinyl]arene.

9. The OLED of claim 2 wherein the blue dopant includes 1,4-bis[2-[4-[N,N-di(p-tolyl)]amino]phenyl]vinyl]benzene (BDTAPVB).

10. The OLED of claim 2 wherein the blue dopant includes a compound of the structure



wherein:

A and A' represent independent azine ring systems corresponding to 6-membered aromatic ring systems containing at least one nitrogen;

(X^a)_n and (X^b)_m represent one or more independently selected substituents and include acyclic substituents or are joined to form a ring fused to A or A';

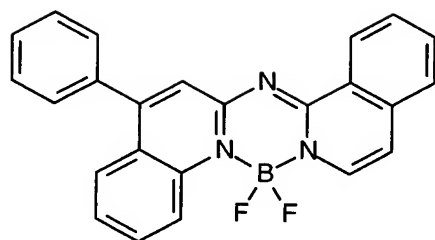
m and n are independently 0 to 4;

Z^a and Z^b are independently selected substituents;

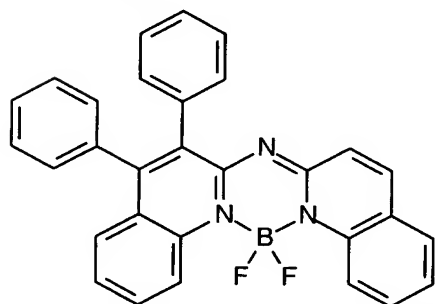
1, 2, 3, 4, 1', 2', 3', and 4' are independently selected as either carbon or nitrogen atoms; and

provided that X^a, X^b, Z^a, and Z^b, 1, 2, 3, 4, 1', 2', 3', and 4' are selected to provide blue luminescence.

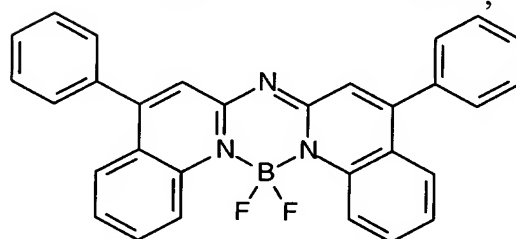
11. The OLED of claim 2 wherein the blue dopant includes a compound of the structure:



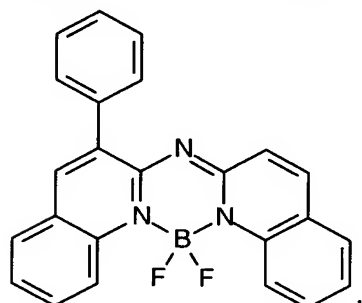
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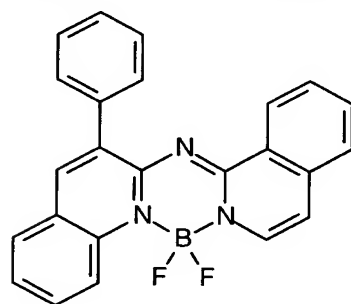
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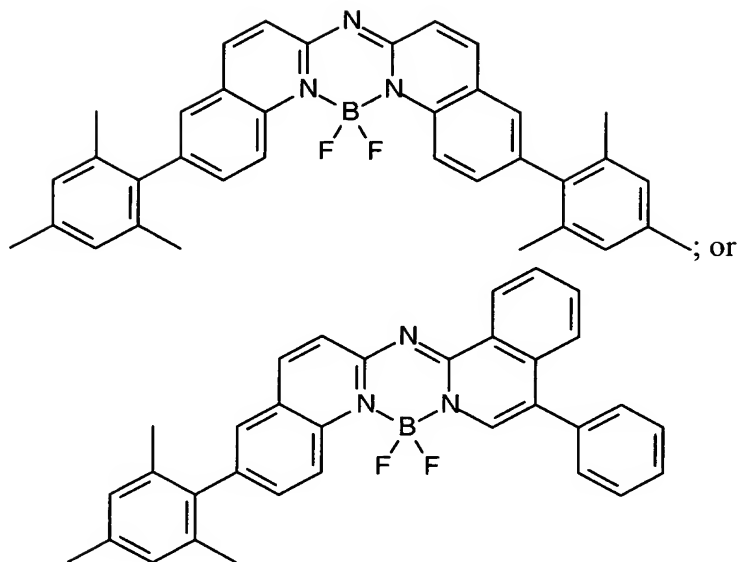
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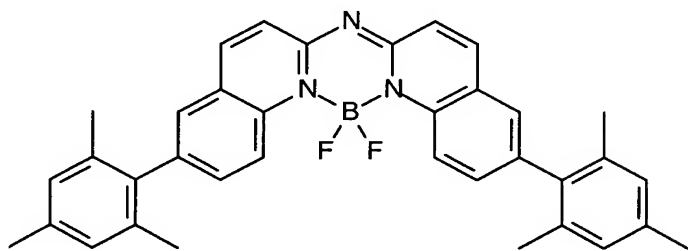
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12. The OLED of claim 2 wherein the blue dopant includes a compound of the structure:



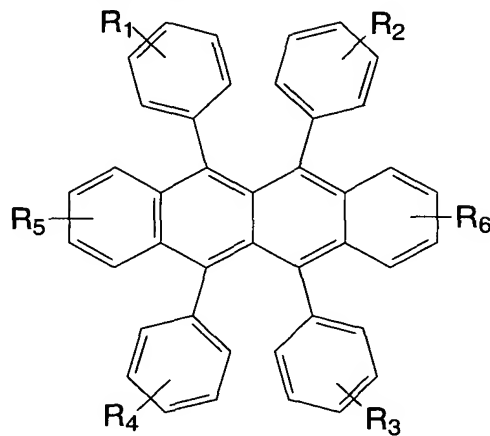
13. The OLED of claim 2 wherein the blue dopant is between 0.1 and 10% by volume of the blue light-emitting layer.

14. The OLED of claim 1 wherein the blue light-emitting layer includes a triarylamine dopant.

15. The OLED of claim 1 wherein the blue light-emitting layer includes NPB or TNB as a dopant.

16. The OLED of claim 1 wherein the hole-transporting layer includes a tertiary aromatic amine.

17. The OLED of claim 1 wherein the yellow dopant includes a compound of the following structure:



wherein R_1 - R_6 represent one or more substituents on each ring and where each substituent is individually selected from one of the following:

Category 1: hydrogen, or alkyl of from 1 to 24 carbon atoms;

Category 2: aryl or substituted aryl of from 5 to 20 carbon atoms;

Category 3: hydrocarbon containing 4 to 24 carbon atoms, completing a fused aromatic ring or ring system;

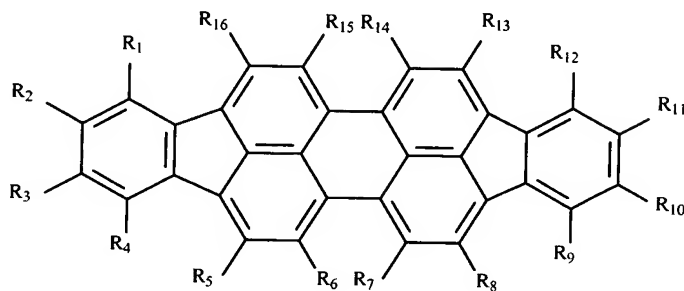
Category 4: heteroaryl or substituted heteroaryl of from 5 to 24 carbon atoms such as thiazolyl, furyl, thienyl, pyridyl, quinolinyl or other heterocyclic systems, which are bonded via a single bond, or complete a fused heteroaromatic ring system;

Category 5: alkoxyamino, alkylamino, or arylamino of from 1 to 24 carbon atoms; or

Category 6: fluoro, chloro, bromo or cyano.

18. The OLED of claim 1 wherein the yellow dopant includes 5,6,11,12-tetraphenylnaphthacene (rubrene); 6,11-diphenyl-5,12-bis(4-(6-methylbenzothiazol-2-yl)phenyl)naphthacene (DBzR); or 5,6,11,12-tetra(2-naphthyl)naphthacene (NR).

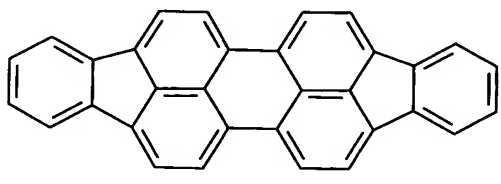
19. The OLED of claim 1 wherein the red dopant includes a diindenoperylene compound of the following structure:



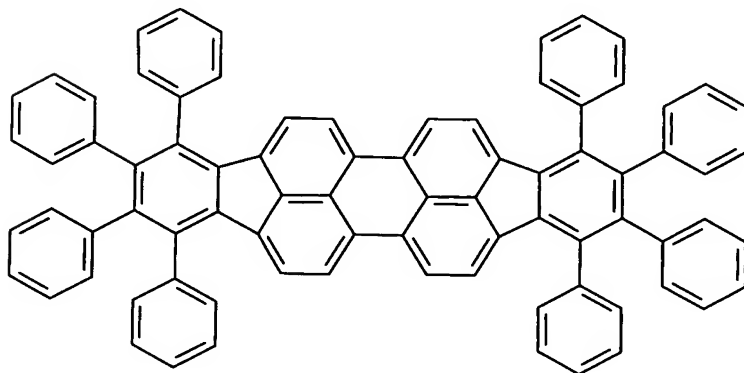
wherein:

R_1 - R_{16} are independently selected as hydro or substituents that provide red luminescence.

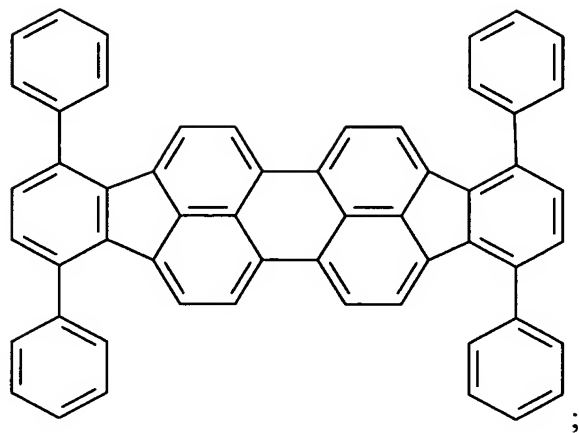
20. The OLED of claim 1 wherein the red dopant includes:



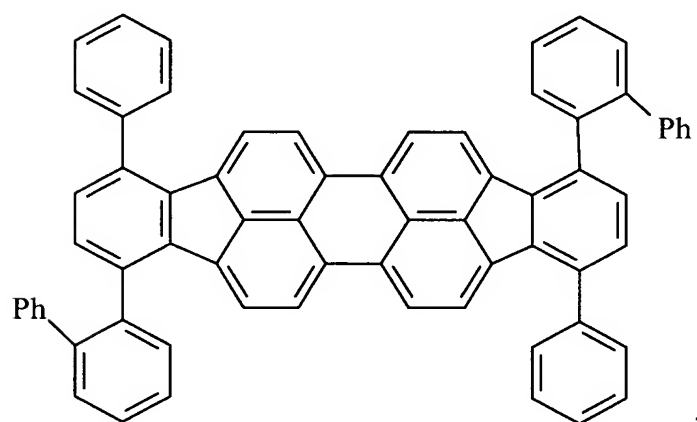
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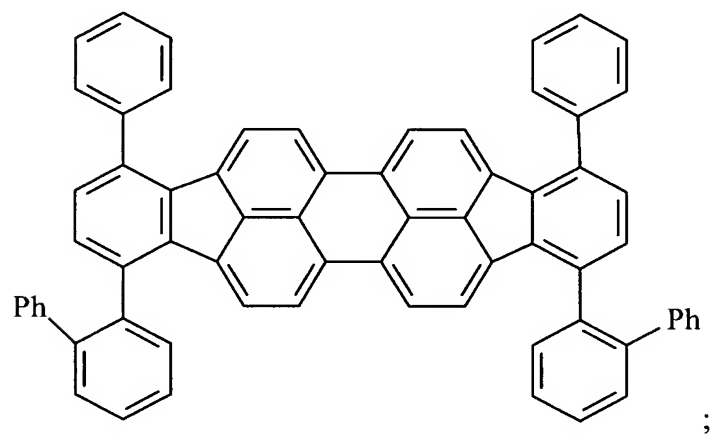
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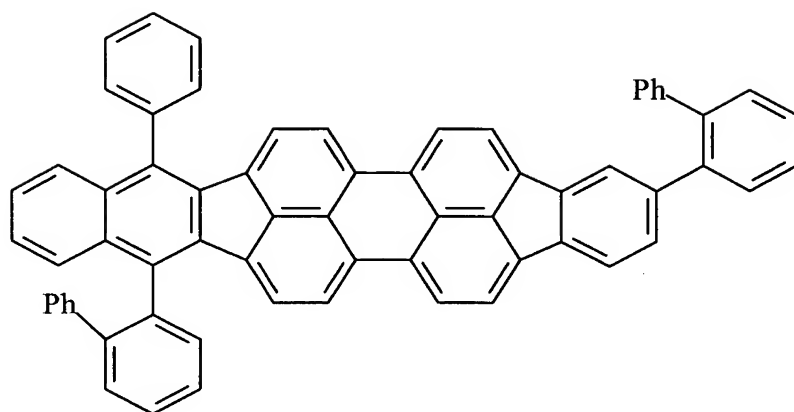
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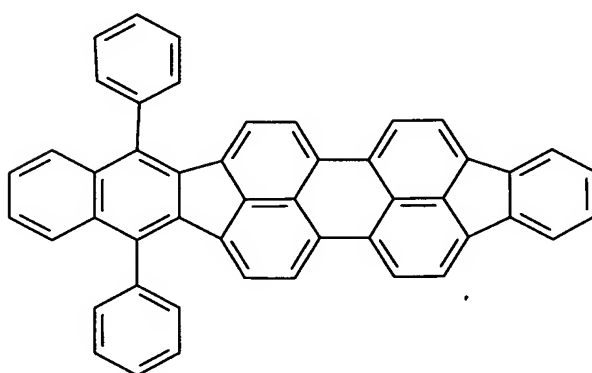
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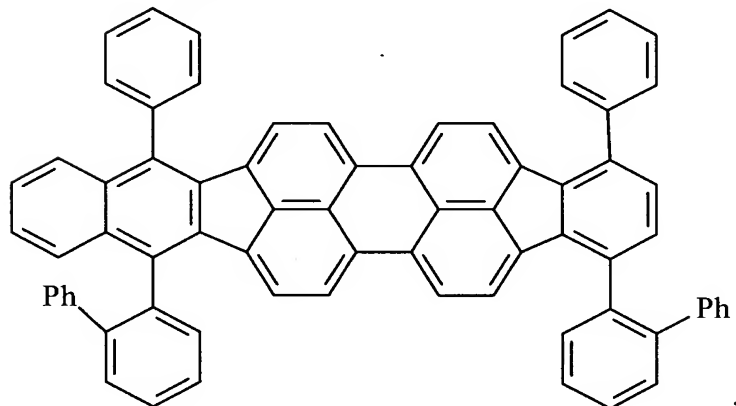
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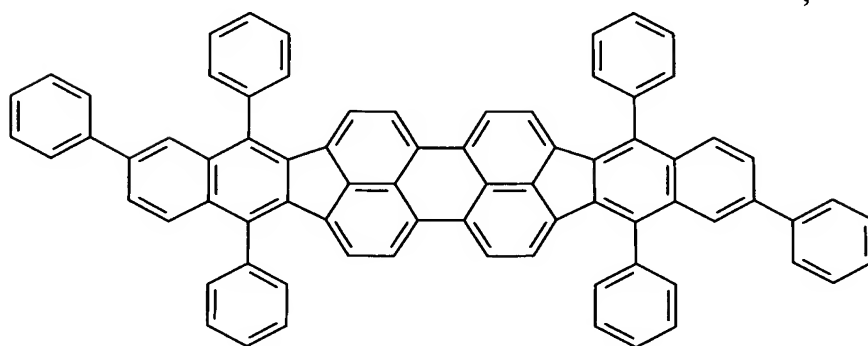
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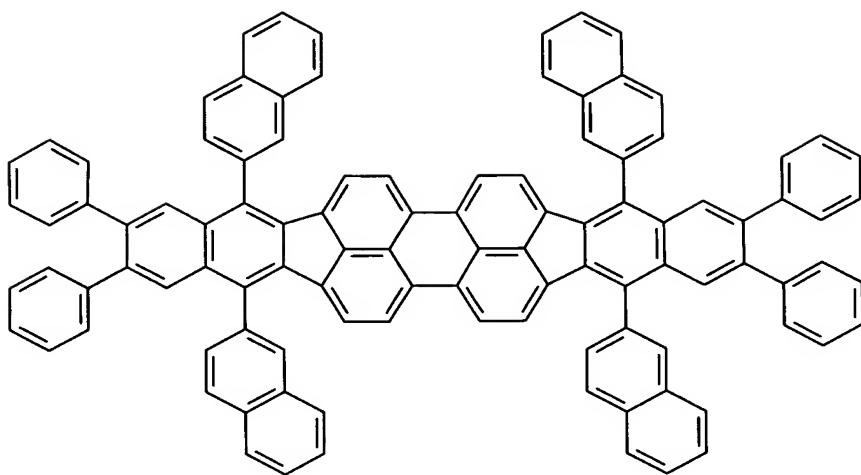
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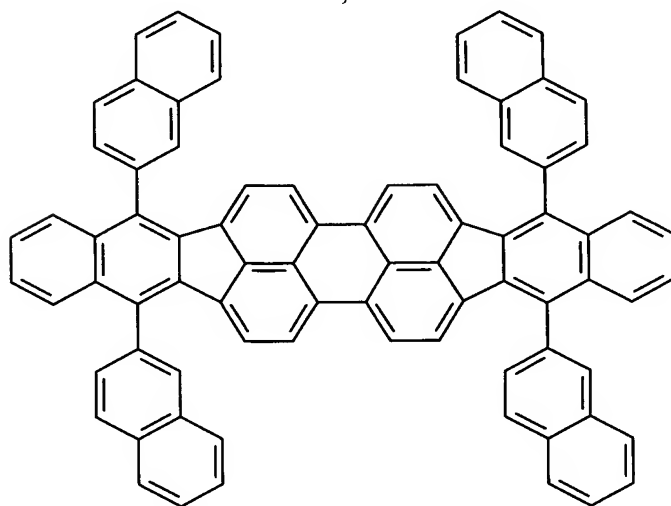
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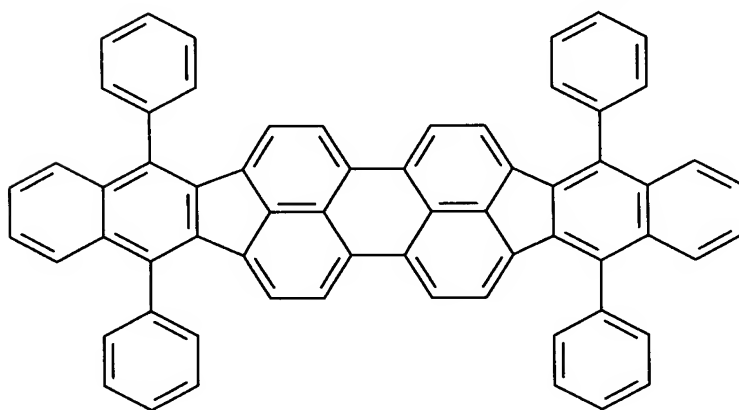
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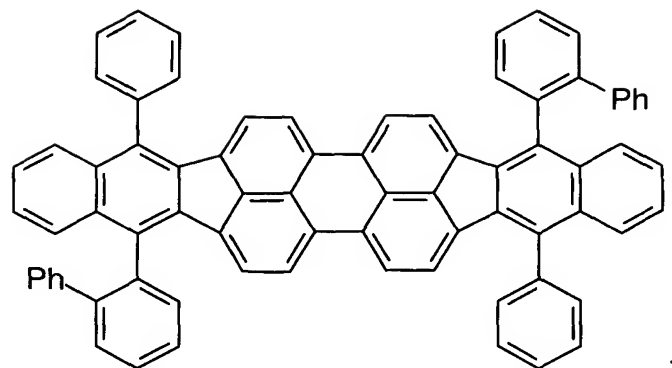
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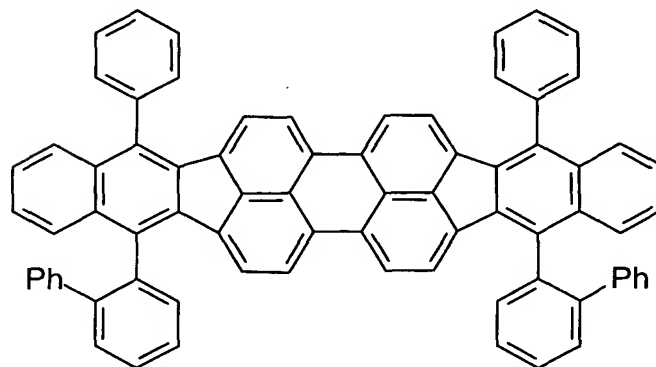
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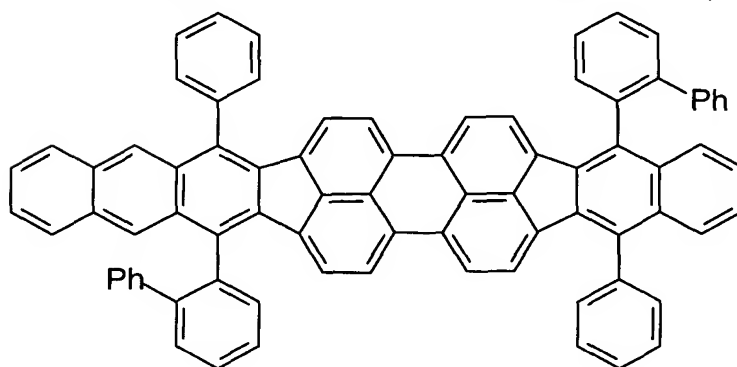
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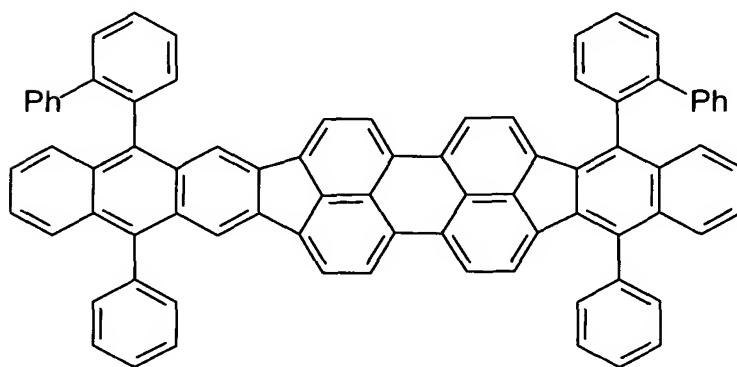
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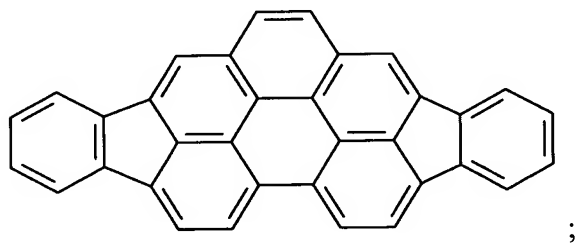
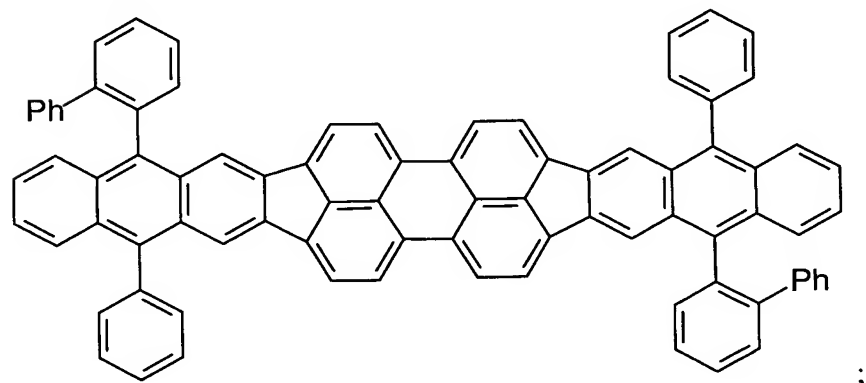
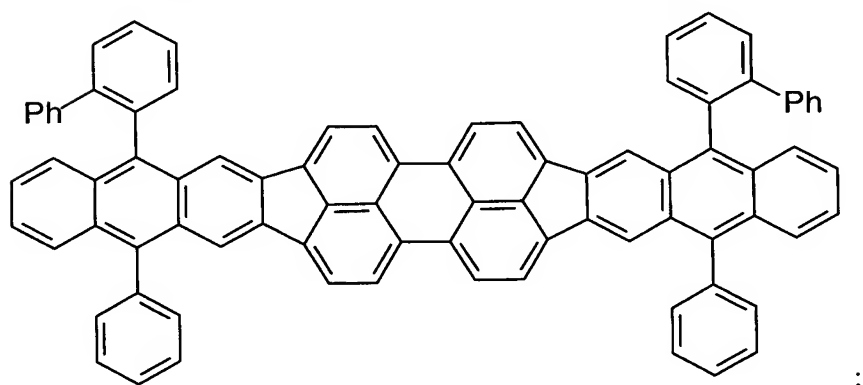
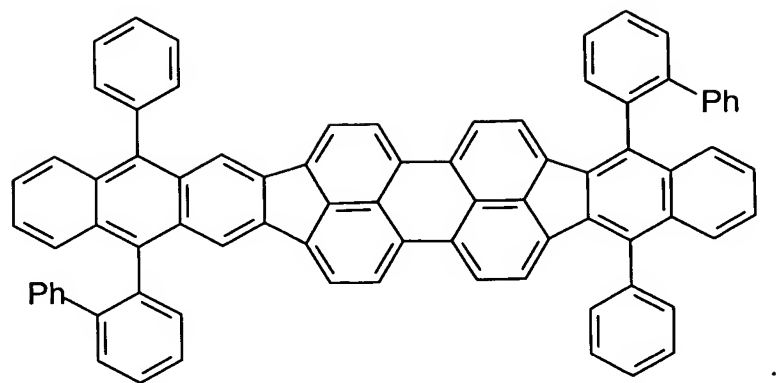
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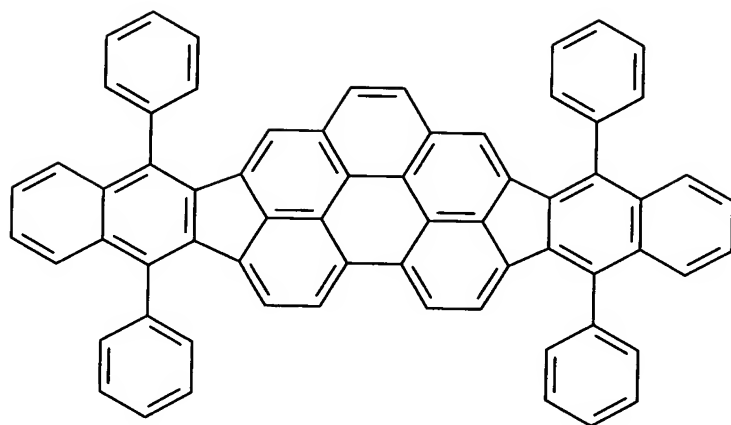


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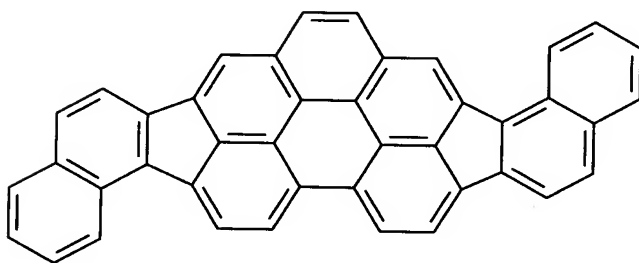


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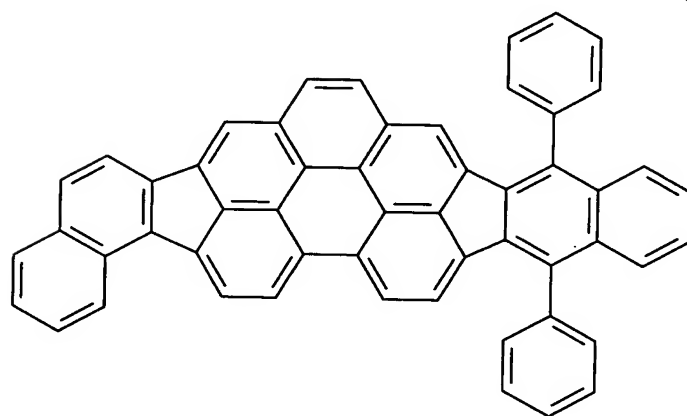




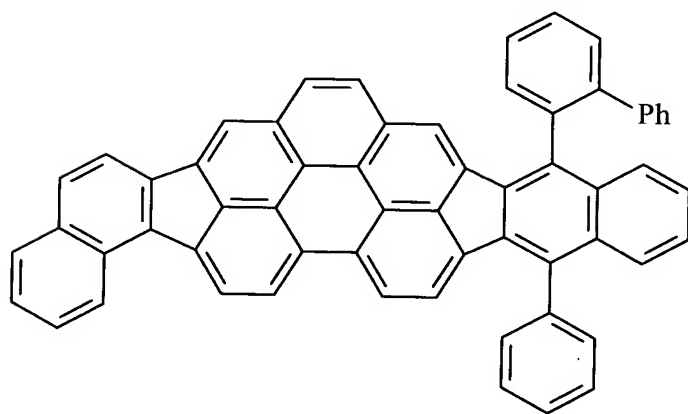
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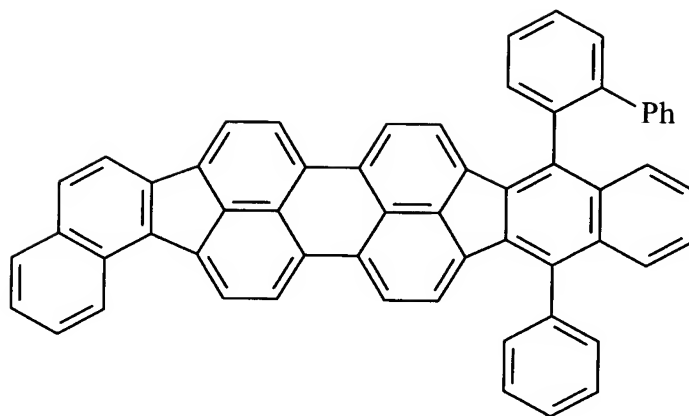
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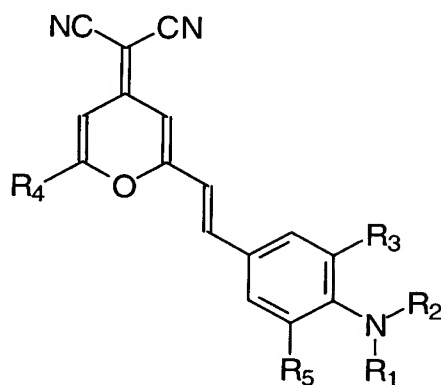


; or



21. The OLED of claim 1 wherein the red dopant compound includes TPDBP.

22. The OLED of claim 1 wherein the red dopant includes a compound of the following structure:



wherein:

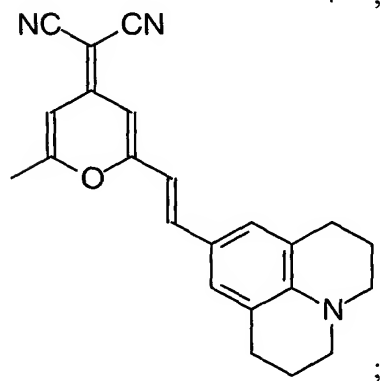
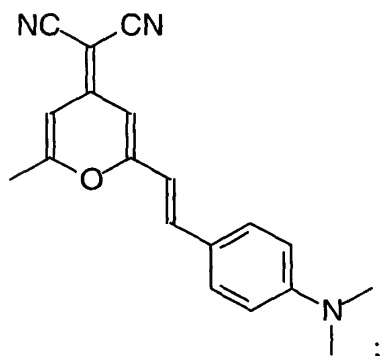
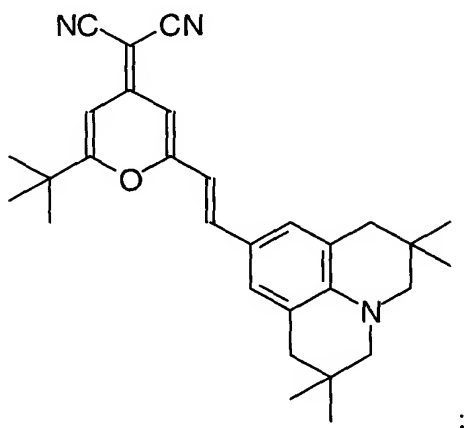
$R_1 - R_5$ represent one or more groups selected independently from: hydro, alkyl, substituted alkyl, aryl, or substituted aryl;

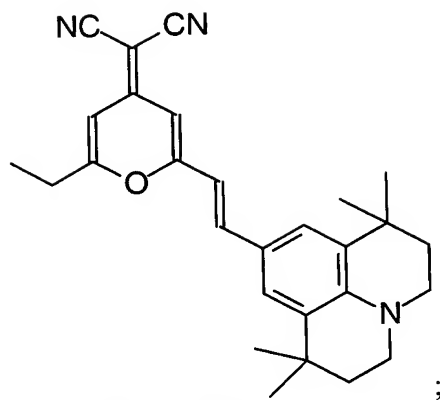
$R_1 - R_5$ independently include acyclic groups or are joined pairwise to form one or more fused rings;

provided that R_3 and R_5 do not together form a fused ring; and

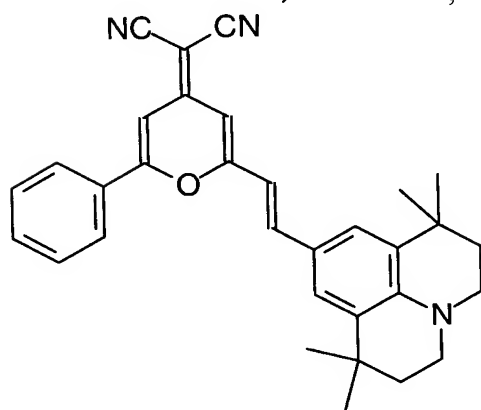
$R_1 - R_5$ are selected to provide red luminescence.

23. The OLED of claim 1 wherein the red dopant includes:

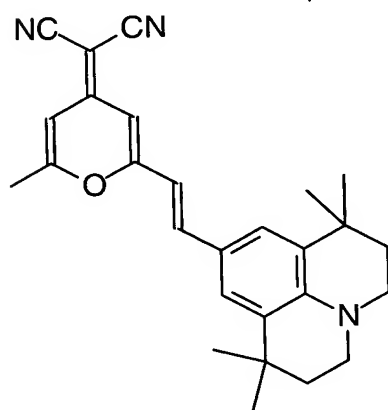




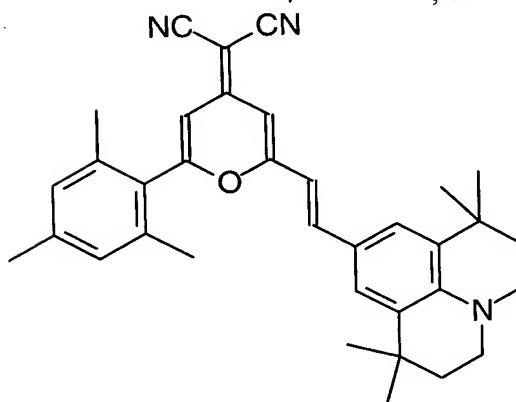
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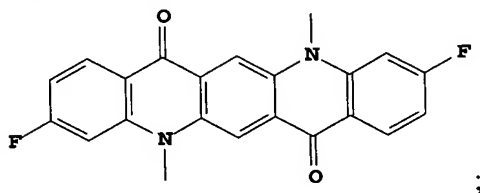
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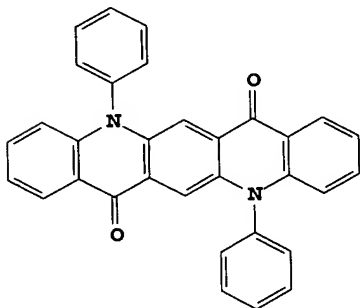
24. The OLED of claim 1 wherein the red dopant is DCJTb.
25. The OLED of claim 1 wherein the yellow dopant is between 0.5 and 50% by volume of the hole-transporting layer.
26. The OLED of claim 1 wherein the red dopant is between 0.1 and 5% by volume of the hole-transporting layer.
27. The OLED of claim 1 wherein the hole-transporting layer includes two or more hole-transporting sub layers, the sublayer closest to the blue light-emitting layer including a host material, a yellow dopant, and a red dopant; and the sublayer closest to the anode not containing the yellow dopant or not containing the red dopant.
28. The OLED of claim 27 wherein the concentration of the yellow dopant is between 0.5 and 50% by volume of the hole-transporting sublayer that is closest to the blue light-emitting layer.
29. The OLED of claim 27 wherein the concentration of the red dopant is between 0.1 and 5% by volume of the hole-transporting sublayer that is closest to the blue light-emitting layer.
30. The OLED of claim 1 wherein the electron-transporting layer includes a green dopant.
31. The OLED of claim 1 wherein the electron-transporting layer includes a coumarin compound.
32. The OLED of claim 1 wherein the electron-transporting layer includes C545T.

33. The OLED of claim 1 wherein the electron-transporting layer includes a quinacridone.

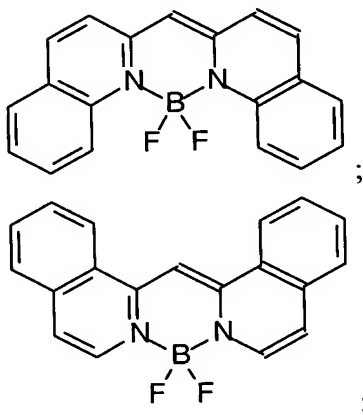
34. The OLED of claim 1 wherein the electron-transporting layer includes:

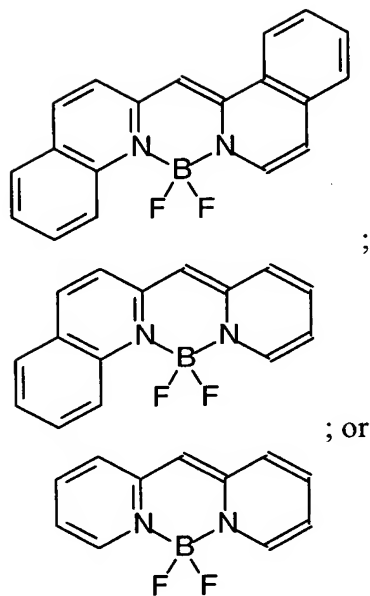


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35. The OLED of claim 1 wherein the electron-transporting layer includes:

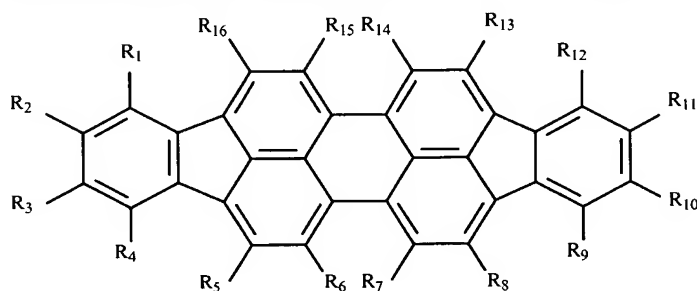




36. The OLED of claim 1 wherein the electron-transporting layer includes two or more electron-transporting sublayers, the sublayer adjacent to the blue light-emitting layer including a green dopant, and the sublayer adjacent to the cathode not containing the green dopant.

37. The OLED of claim 1 wherein the electron-transporting layer includes a red dopant.

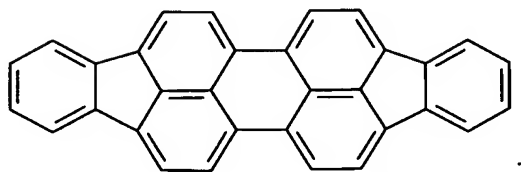
38. The OLED of claim 1 wherein the electron-transporting layer includes a diindenoperylene compound of the following structure:



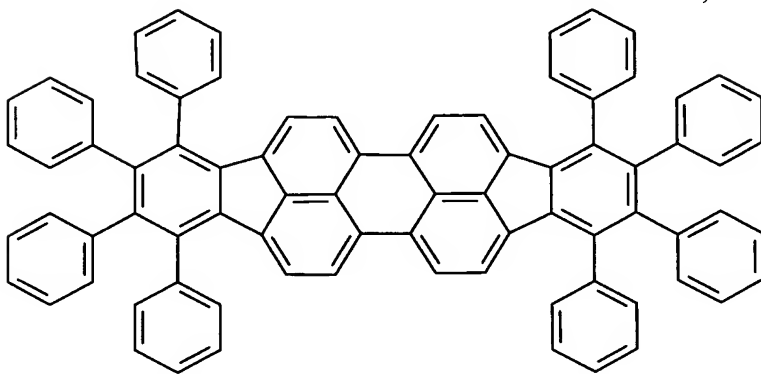
wherein:

R_1 - R_{16} are independently selected as hydrogen or substituents that provide red luminescence.

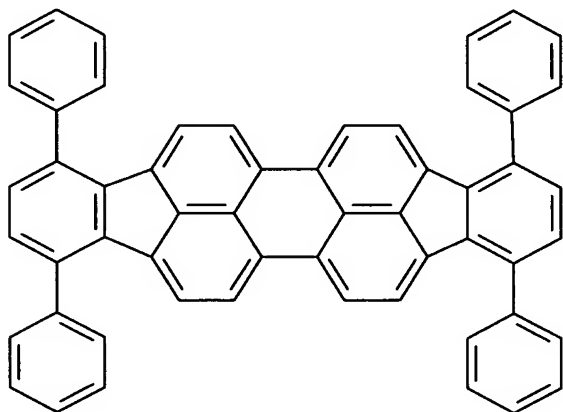
39. The OLED of claim 1 wherein the electron-transporting layer includes:



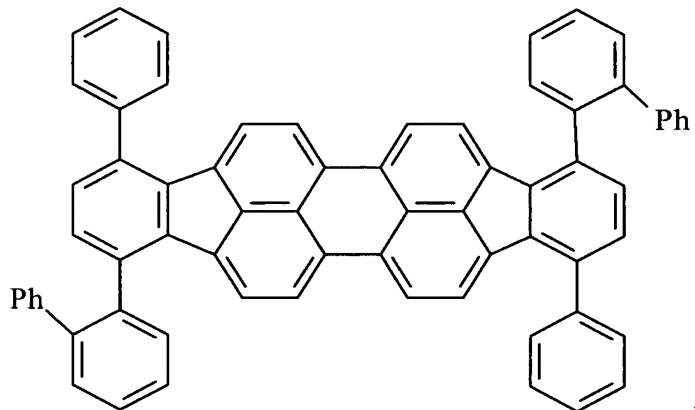
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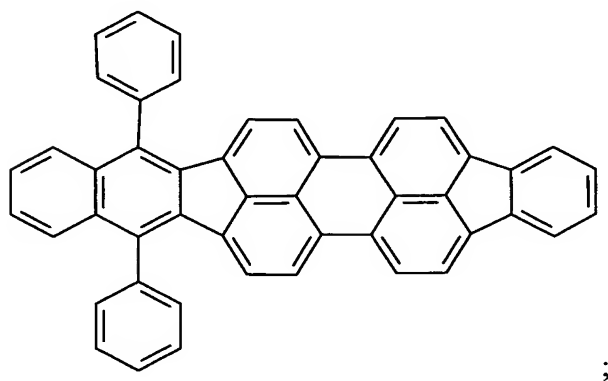
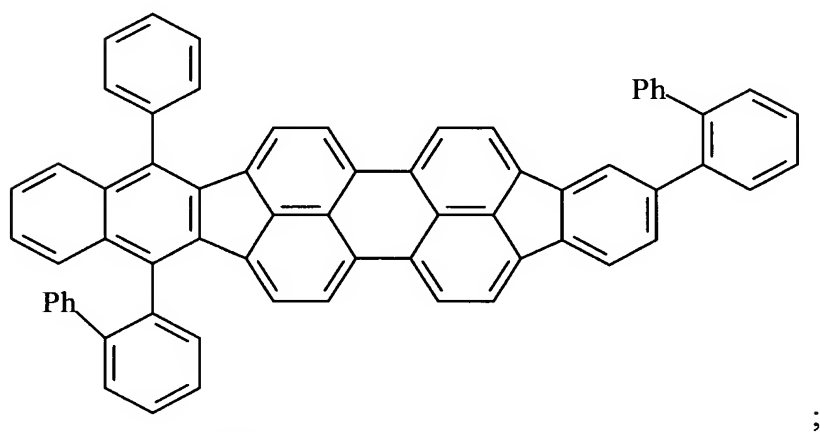
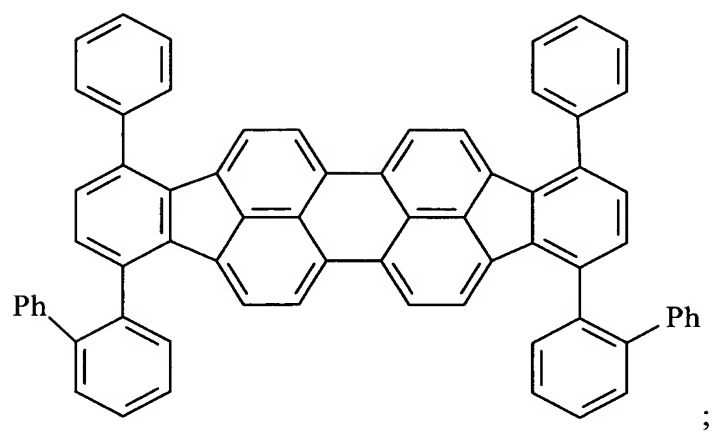
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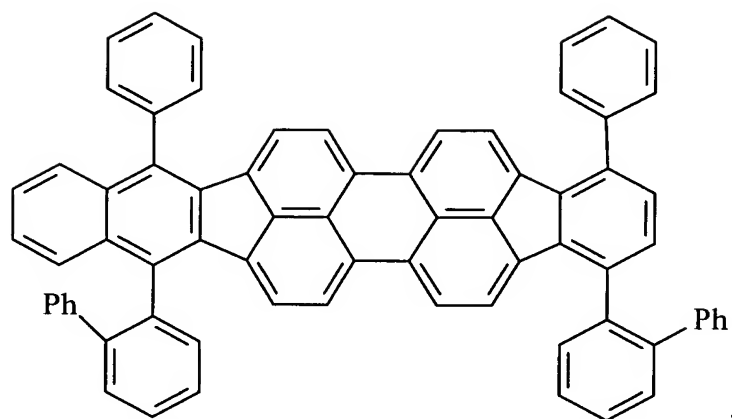


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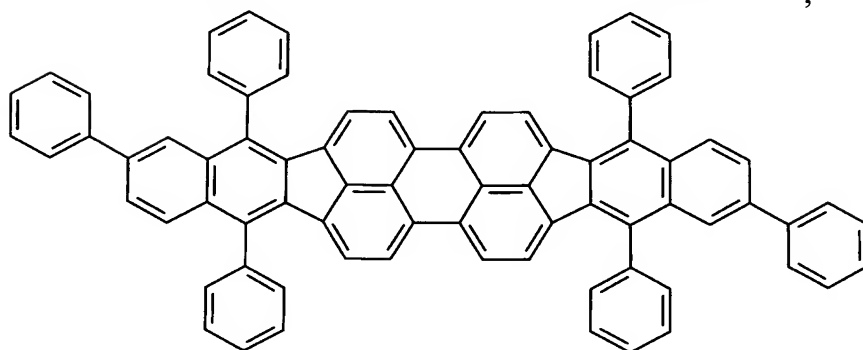


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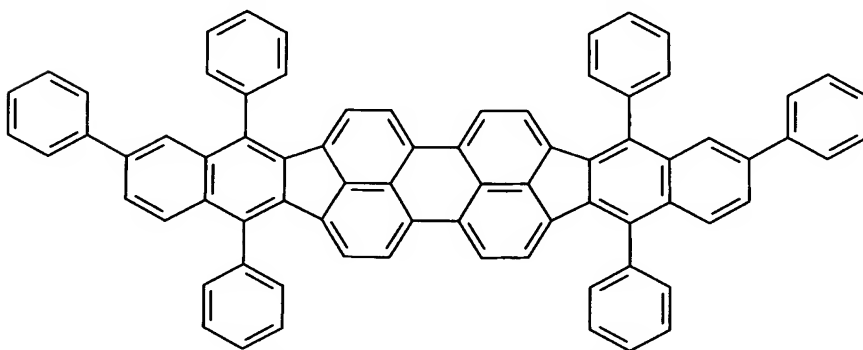




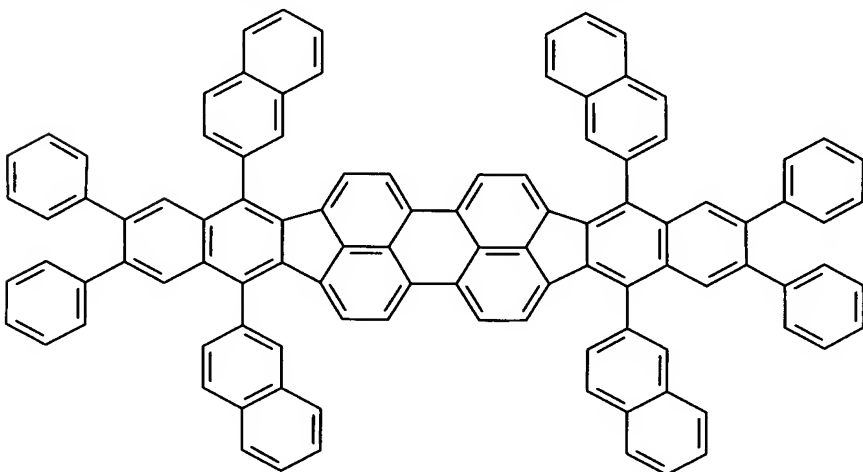
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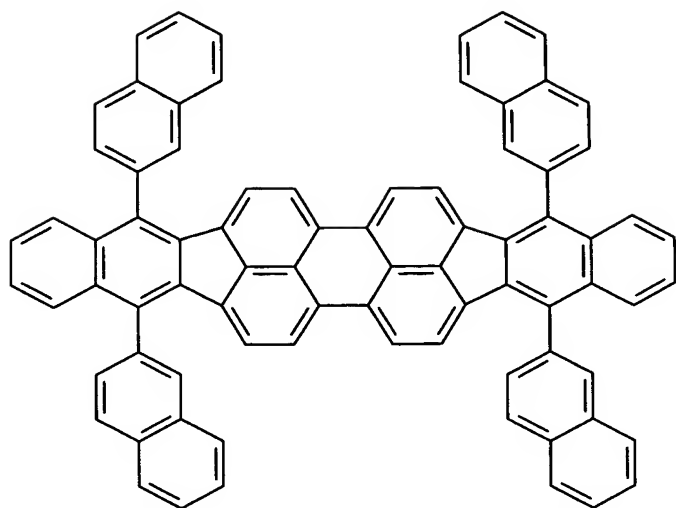
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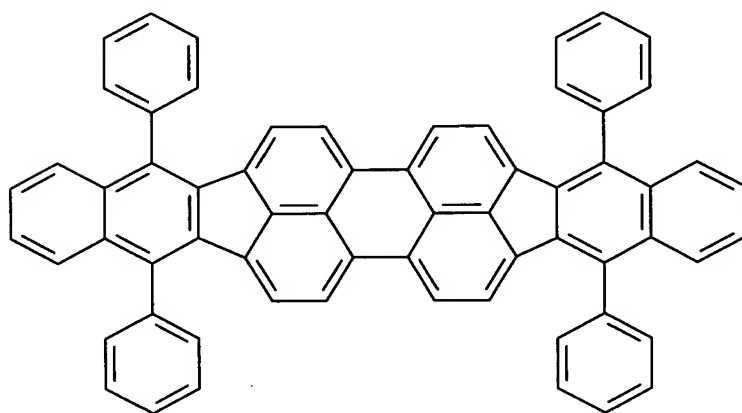
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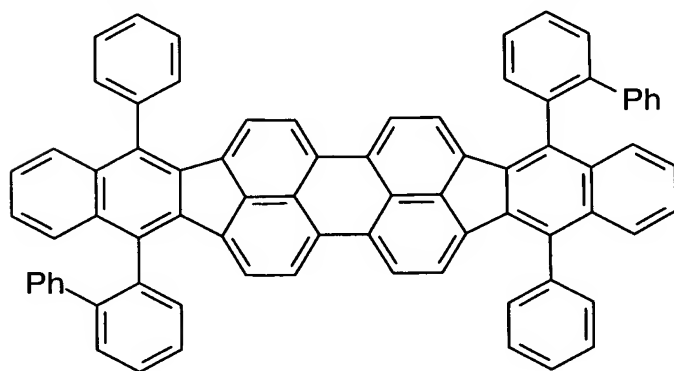
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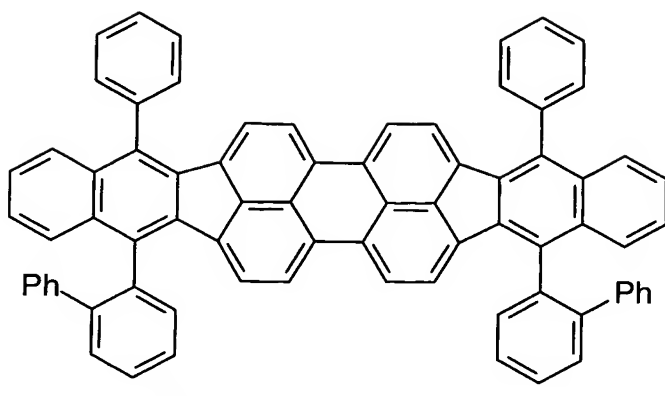
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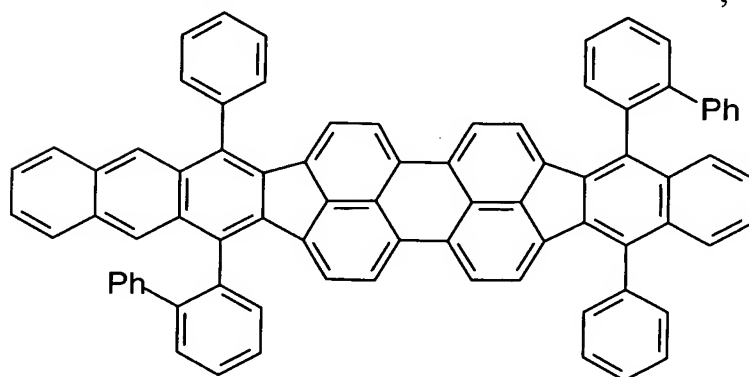
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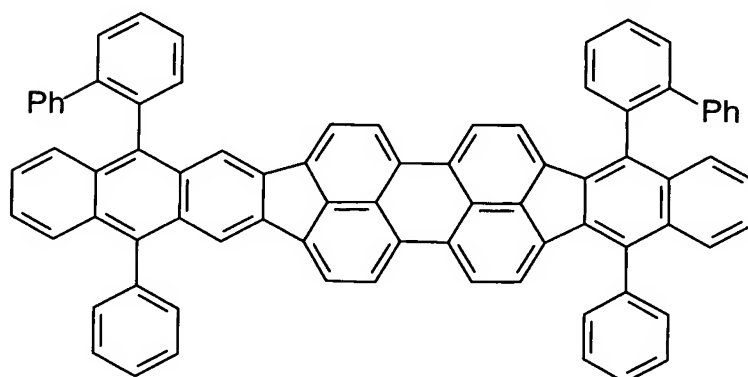
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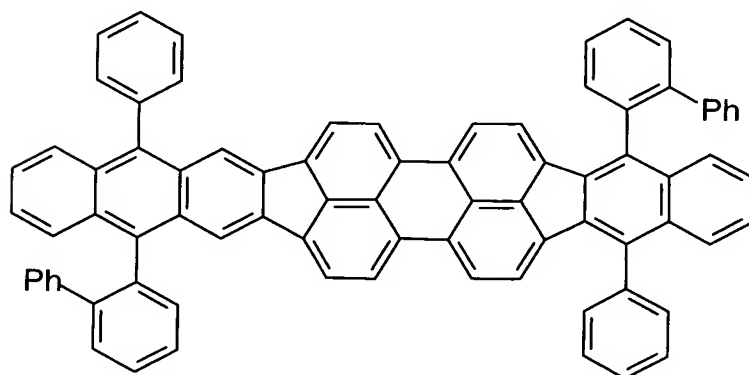
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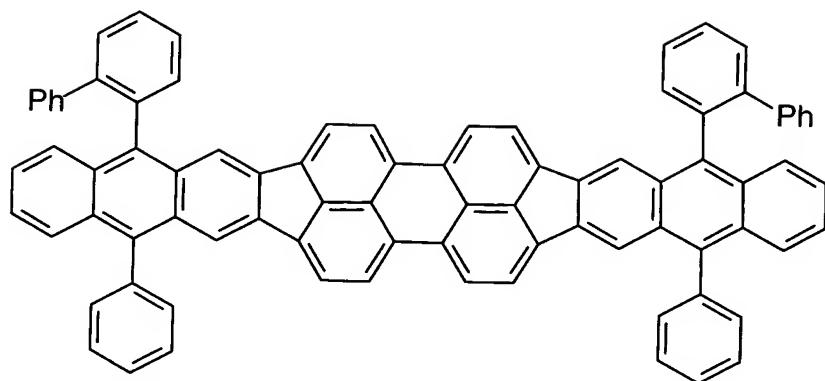
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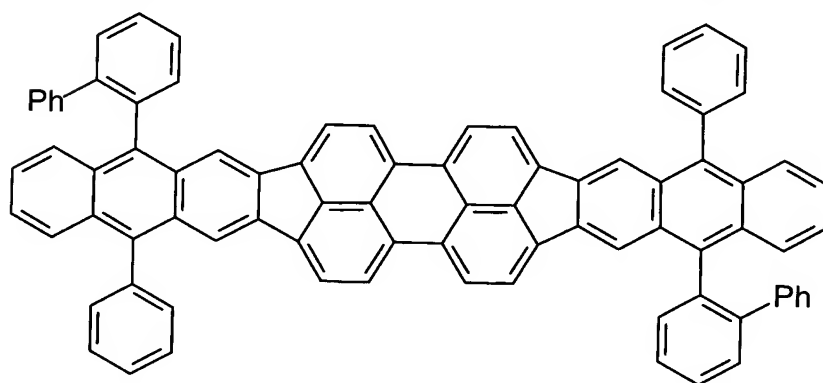
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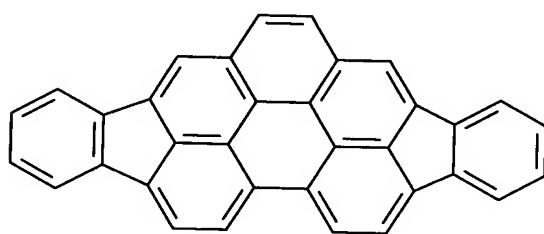
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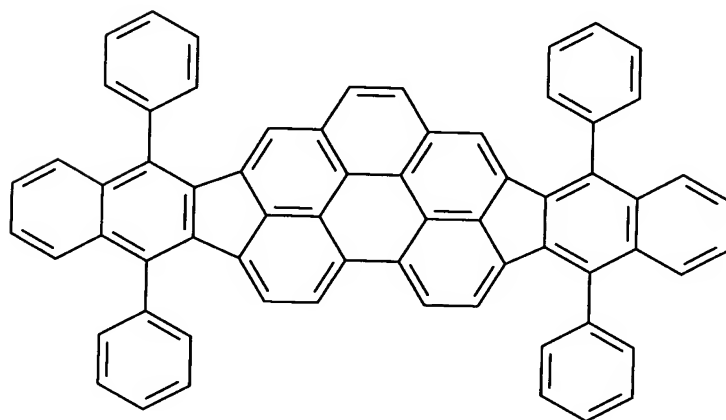
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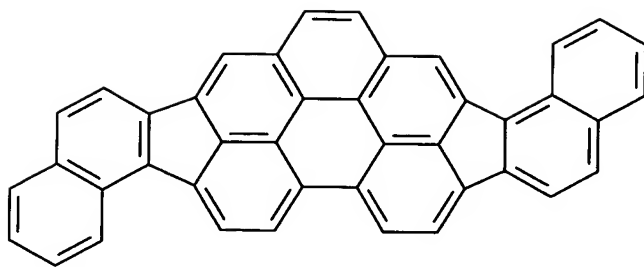


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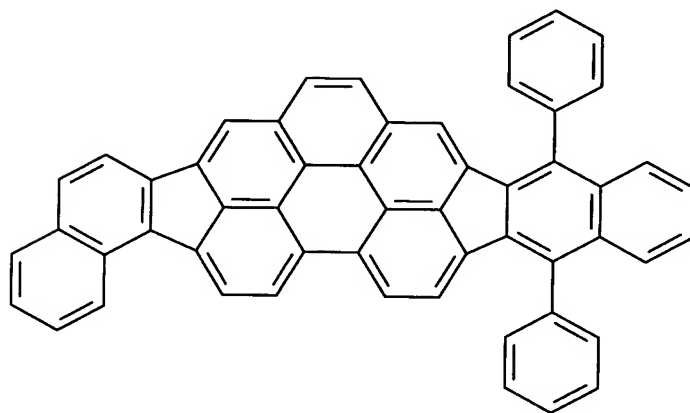


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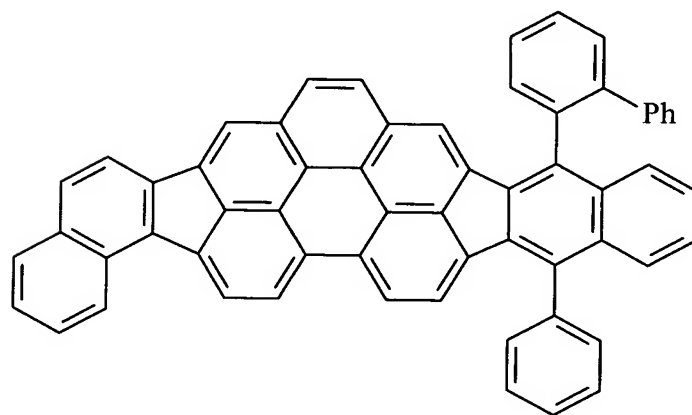
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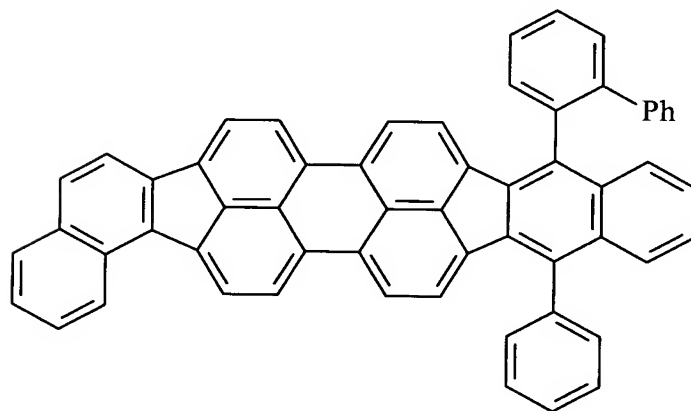
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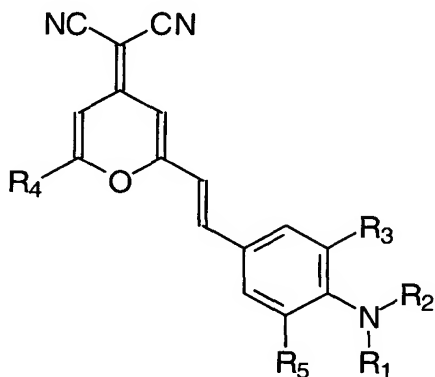


; or



40. The OLED of claim 1 wherein the electron-transporting layer includes TPDBP.

41. The OLED of claim 1 wherein the electron-transporting layer includes a compound of the following structure:



wherein:

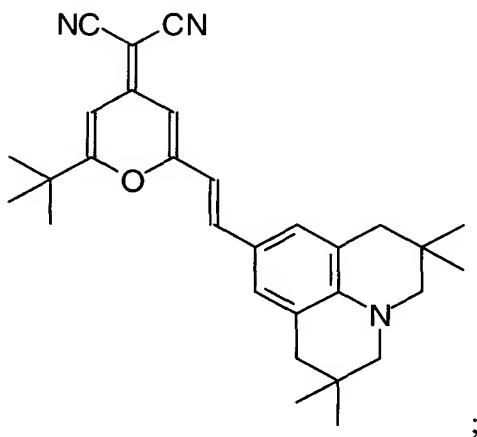
$R_1 - R_5$ represent one or more groups selected independently from: hydro, alkyl, substituted alkyl, aryl, or substituted aryl;

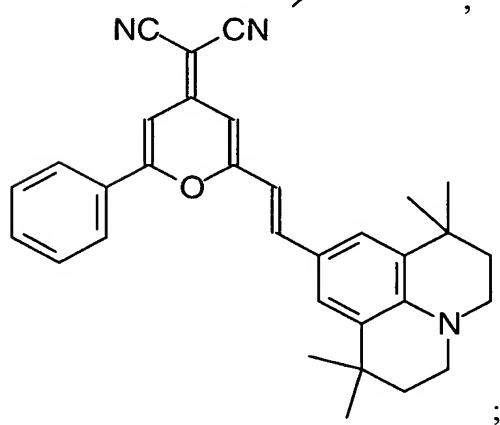
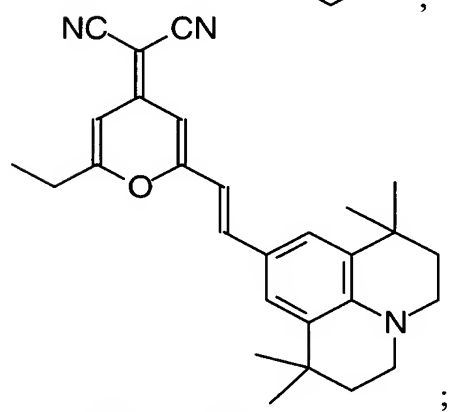
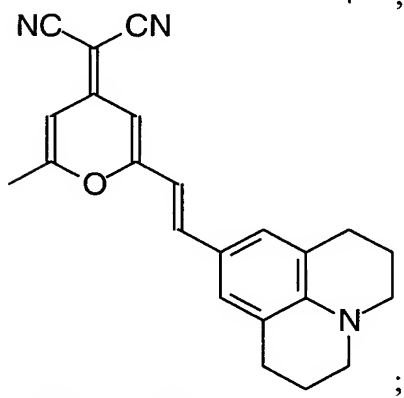
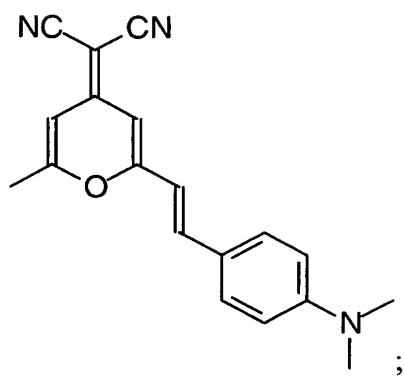
$R_1 - R_5$ independently include acyclic groups or are joined pairwise to form one or more fused rings;

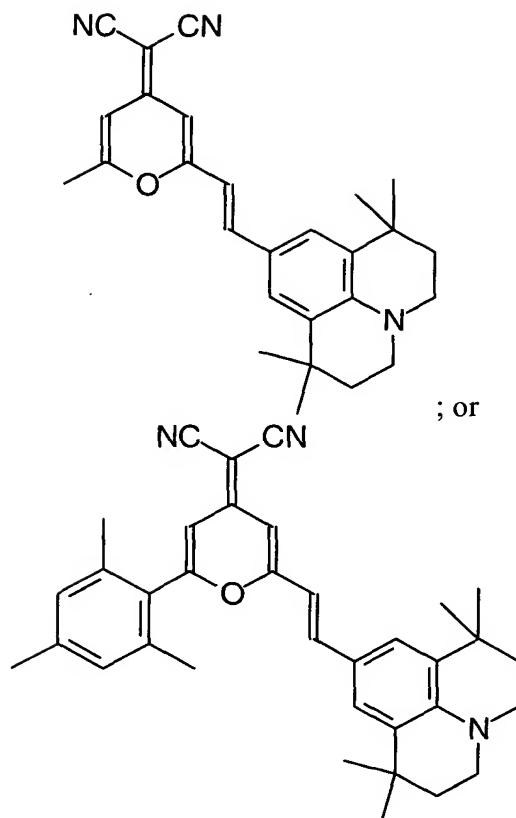
provided that R_3 and R_5 do not together form a fused ring; and

$R_1 - R_5$ are selected to provide red luminescence.

42. The OLED of claim 1 wherein the electron-transporting layer includes:







43. The OLED of claim 1 wherein the electron-transporting layer includes DCJTB.

44. A light-emitting display including:

a) a plurality of OLEDs that produce white light when current is driven through them, each OLED including:

- i) an anode;
- ii) a hole-transporting layer disposed over the anode;
- iii) a blue light-emitting layer disposed over the hole-transporting layer;
- iv) an electron-transporting layer disposed over the blue light-emitting layer;
- v) a cathode disposed over the electron-transporting layer; and

vi) the hole-transporting layer including a host material, a yellow dopant and a red dopant; and

b) an array of color filters, including red, green, and blue filters, disposed in the display, each filter corresponding to a different OLED such that the white light produced by each OLED is filtered by its corresponding filter.

45. The display of claim 44 further including a substrate, wherein the color filter array is disposed above the substrate and the anode is disposed above the color filter array, or wherein the anode is disposed over the substrate and the color filter array is disposed above the cathode.

46. A light-emitting display including:

a) one or more OLEDs that produce white light upon passage of electrical current through the OLED(s), each OLED including:

- i) an anode;
- ii) a hole-transporting layer disposed over the anode;
- iii) a blue light-emitting layer disposed over the hole-transporting layer;
- iv) an electron-transporting layer disposed over the blue light-emitting layer;
- v) a cathode disposed over the electron-transporting layer; and

vi) the hole-transporting layer including a host material, a yellow dopant and a red dopant; and

b) an array of color filters, including red, green, and blue filters, disposed in the display such that the white light produced by the OLED(s) is filtered through the color filters; and

c) an array of liquid-crystal light valves, each light valve corresponding to a different color filter, disposed in the array such that the white light produced by the OLED(s) and filtered by the color filter is adjusted in brightness by the liquid-crystal light valves.